Performance in Emotionally Stressful Tasks:

An Investigation into Potential Sex Differences

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Abstract

The current investigation focuses on sex differences in the appraisal of stress and emotional processing. It is hypothesized that men and women vary greatly in performance on stressful tasks, in terms of physiological arousal patterns and self-reports on subjective stress experiences. Two sets of short vigilance tasks were individually completed by 40 participants, one in a negative and the other in a neutral picture stimuli condition. Participants also completed three stress state questionnaires; one prior to the vigil, another between the two sets and the final one after the vigil. Additionally, physiological brain activity was measured using a neuroimaging technique. The results revealed the impact of emotions, in particular negative stimuli, on task performance, physiological arousal and stress states. Men and women only significantly differed in their subjective ratings of stress. Explanations and implications are discussed with reference to gender socialization patterns.

Introduction

Background

"The chief distinction in the intellectual powers of the two sexes is shown by man's attaining to a higher eminence, in whatever he takes up, than can woman." – Charles Darwin (1871)

Stress and sex differences [1] have been popular areas of investigation in psychology since it was first established as a formal discipline in 1879. An early finding in the systematic inquiry into sex differences was variability across individuals. Francis Galton's (1897) pioneering experiment on two point discrimination (how close together two point contacts on the skin feel separate) in men and women produced results showing that women have superior sensitivity; however, because of their increased variability in responses, the results were interpreted to show that women were less able to sustain their attention to the task at hand. Essentially, women were unreliable and unstable, whereas men were reliable and stable. Galton's attempted justification of men's superiority, despite women actually having more sensory resolution, reflects the cultural concern with finding biological evidence for men's superior position in society prevalent at the time.

Darwin's evolutionary theory influenced the young science of psychology immensely; providing a reason to study differences between men and women. Anatomical differences were among the first to be observed and it was found that women on average have smaller head sizes and smaller brains, which were associated with different levels of intelligence

[1] In the literature the terms sex difference and gender difference are used interchangeably (Hyde, 2005). However in the context of this research, the definition sex difference is used as the experiment focused on difference of individuals, who are male or female. On the other hand, gender difference describes the sociocultural environment that these differences exist in and are therefore to some aspect socially constructed.

(Shields, 1995). This was undoubtedly offered up as justification for inequality; men were biologically (e.g. naturally) more reliable, stable, “brainy” and so on.

For centuries, stereotypical beliefs like this have restricted women from gaining equal access to society. These stereotypes about the emotional, irrational, and unstable female and the rational, stable male were adopted by Western philosophy (Fischer & Manstead, 1995). Gender roles have been more defined and clear cut since the Industrial Revolution. Sex stereotypes still exist today; the belief that women are more emotional and less strong-minded is a factor that impacts women for example in the workforce or during negotiations (Hyde, 2005). Even preschool children know the stereotypical beliefs about sex differences in emotional experience and expression (Feldman-Barrett, Robin, Pietromonaco & Eyssel, 1998).

Since the early origins in philosophy and differential psychology, research into differences between sexes has generated numerous books, articles and theories. The nature of inquiry has changed from one trying to confirm stereotypes to recognition of differences with little functionality (Dittmar, Warm, Dember & Ricks, 1993). In this line of inquiry, sex-specific patterns of cognitive and emotional processes have been formulated. The identification of these patterns has the potential to enhance the practice of scientist - practitioners in areas such as stress management and automation control (Gildea, Schneider & Shebilke, 2007).

Although the interest in psychological sex differences dates back to the beginning of formal psychology, early research also reported that these differences are too small to be noticed in comparison to within - gender variation (Thorndike, 1914). Since then, many sex differences have been identified in areas such as cognitive processes, stress reactions and emotions. In this context, a gender similarities hypothesis has also been proposed, introducing the concept that men and women are more similar to each other in most psychological variables (Hyde, 2005). In an inquiry into 46 different meta-analysis studies, six categories of gender differences are studied – among them cognitive variables, verbal/non-verbal communication, social/personality dimensions and psychological well-being. Hyde (2005) examined the effect sizes of these studies and found 78 percent of those translated in little or no support for gender differences and therefore argues that the majority of differences found are so minimal that they are negligible. Past research has consistently found sex differences in language processing and visuospatial performance (Leon-Carrion et al., 2006). Men generally exceed in tasks involving mental rotation and spatial perception, while women do better at language tasks such as verbal memory and language processing.

Stress Research.

Since its formal conceptualization in 1976, the concept of psychological stress has generated a substantial amount of research and has since become a prevalent factor in psychological theory (Shield, 1995). In general, the stress experience is very subjective and can manifest itself through physiological, behavioral and cognitive processes. Depression and anxiety are common examples of affective emotions in stressful situations (Gardner & Fletcher, 2009).

The contemporary transactional model of stress views stress as a cognitive process and a relationship between demands of the task and the individual's ability to cope with these demands (Lazarus & Folkman, 1984). However, the practicality of this model lies in its generality and thus only provides vague information about cognitive processes. Two appraisal steps help determine if a situation is perceived as stressful. Primary appraisal processes evaluate the demand and determine whether or not the stimulus is a threat. Subsequently, secondary appraisal processes provide assessments about the available coping resources. A large body of research has investigated the mechanics underlying appraisal and coping. The general conclusion is that men and women are exposed to a range of gender specific stressors and also differ in the level of stress that they report (Gardner & Fletcher, 2009). Women generally report higher levels of stress (Matud, 2004) and make more threat appraisals about situations than men (Eaton & Bradly, 2008). Moreover, it was also concluded that men tend to perceive stressful situations as *both* a threat *and* a challenge, while women view such situations as *either* a threat *or* a challenge (Gardner & Fletcher, 2009).

In a performance context, stress refers to task demands that may overload a person's ability to cope with the task load (Matthews et al., 2002). Task induced stress is ubiquitous in a range of operational settings, such as industrial operations, transportation, and medical practice. The reliance on machines and automation has reduced the operator's sense of control, leading to an increase in role ambiguity. Work activities associated with these environments may be inherently stressful even in the absence of external stressors.

In this investigation performance is important; therefore it will be restricted to task-induced stress. Matthews et al. (2001) concluded that tasks with a short duration can harm performance by provoking stress reactions. The concept of task induced stress is a common issue within many areas of ergonomics (Gildea et al., 2007).

Emotion and Its Expression.

Stressful experiences are connected with strong and arousing emotions. Research has confirmed emotions have a powerful influence on how people react in a given situation and subsequent performance. Maladaptive stress behaviour results in higher job burnout, stress, work exhaustion and overload. Previous research has found neurobiological differences in the processing of emotions in men and women (Leon-Carrion et al, 2006; Lithari et al., 2010). In psychopathology, life - time prevalence for depression is higher in females than in males (Kemp, Silberstein, Armstrong & Nathan, 2003).

Emotions and moods (e.g. more persistent states) are the underlying elements of stress responses. Multidimensional measures of stress are better to study as they provide more information about the subjective state of people than a single measure of stress (Feldman - Barrett et al., 2003). Emotional expression has been described as one of the areas where gender differences are most pronounced (Kring & Gordon, 1998).Women are more emotionally expressive than men but do not differ in reported experienced emotion. These expressions are believed to be socially constructed as the presence of other's triggers gender – specific social display rules (LaFrance & Banaji, 1992; Kring & Gordon, 1998). LaFrance and Banaji (1992) suggest further that gender differences in emotionality are likely to depend on the methodology used and the emotion examined.

The Present Study

Dundee Stress State Questionnaire.

Since emotions and stress are subjective experiences, the best possible way to access and measure them is directly through the participant, e.g. self-reports. One instrument frequently used in conjunction with vigilance tasks is the Dundee Stress State Questionnaire (DSSQ; Matthews et al., 2002). It has been developed to reflect the multidimensionality of stress states (arousal, mood and fatigue) and designed to measure affective, motivational and cognitive state changes through a self-report format. In order to detect these changes due to task demands, pre-task and post-task versions of the DSSQ have been developed. Validity studies have shown that the DSSQ is sensitive to environmental stress factors, therefore ideally suited to measure immediate stress state (Szalma et al., 2004).

The specific subscales of the DSSQ of interest in this study are Energetic Arousal (EA; alert – lethargic), Tense Arousal (TA; nervous-relaxed), Task Relevant Cognitive Inference (e.g. worry about task performance), and Task Irrelevant Cognitive Inference (e.g. worry about things other than the task). The items for the DSSQ scales were sampled from different sources. For energetic arousal and tense arousal items from the UWIST Mood Adjective Checklist (UMACL; Matthews et al., 1990) were used. This checklist has been validated both experimentally and in applied settings. The scales for Task Related Thought (TRT) and Task Unrelated Thoughts (TUT) are derived from Sarason et al.’s (1986) task-relevant and task-irrelevant cognitive inference scales.

Numerous studies have used the Dundee Stress State Questionnaire in vigilance experiments (Grier et al., 2003; Matthews et al, 2001, Smallwood et al., 2004; Helton Dorahy, Russell, in press; Szalma et al., 2004; Warm Parasuraman & Matthews, 2008). Typically, a decrease in energetic arousal is accompanied by an increase in tense arousal, indicating that vigilance is emotionally stressful (Matthews et al., 2002; Szalma et al., 2004; Warm et al., 2008). These finding have been replicated in many experimental vigilance studies and also found in applied settings such as long-distance driving. The Dundee Stress State Questionnaire is therefore a suitable instrument to explore stress responses in sustained performance.

Vigilance task.

Recent technological developments in automation, as well as the increased prevalence of automation in human-machine systems, makes vigilance (e.g. monitoring) an important factor in human performance work (Parasuraman & Wickens, 2008; Warm et al., 2008). Vigilance, also referred to as sustained attention describes a state in which attention must be maintained over time, such as monitoring system displays for warning signals or critical events (Szalma, 2009). For human performance research this concerns the ability to detect brief and unpredictable signals over time (Davies & Parasuraman, 1982; Matthews, Davies, Westerman, & Stammers, 2000; See et al., 1995). In applied settings, the ability of sustaining attention is vital during prolonged driving, scanning luggage or postal items for potential threats or during monitoring of medical devices (Hancock & Hart, 2002; Helton, Warm & Kern, 2009). Given the importance of vigilance in such routine tasks, it has been extensively studied and evidence from neurological impairment and disorders clarifies areas of impacts on sustained attention (Ballard, 2006; Davies & Parasuraman, 1982; Irani, Platek, Bunce, Ruocco & Chute, 2007).

Despite extensive training and adequate motivation a decrease in the ability to maintain focus and thus detect target stimuli has been observed over time (Davies & Parasuraman, 1982; Warm et al., 2008). This phenomenon was first described formally during the Second World War with the introduction of radar and sonar. Subsequently, Mackworth (1948) systematically studied this phenomenon and termed it the vigilance decrement. A generally excepted explanation for this decline in performance over time is the resource depletion – mental fatigue theory; this theory proposes that lapses in sustained attention are a result of a reduction in available attention resources necessary for sustained attention over a prolonged period of time (Grier et al. 2003, Helton et al., 2009; Matthews et al., 2000). During vigilance tasks observers are consistently engaged in discrimination between target and non-target stimuli under conditions of great uncertainty (Davies & Parasuraman, 1982; Temple et al., 2000; Warm et al., 2008). Due to this continuous mental work, there is little opportunity of rest to recover resources necessary for the task; therefore these resources get used up faster than they can be replenished and an increased number of lapses occur (Szalma et al, 2009).

Traditionally, vigilance tasks require observers to monitor displays for prolonged periods of time. Early vigilance experiments had durations of up to two hours, with a decrease in detection becoming apparent after 30 minutes (Mackworth, 1948). The duration of the original experimental vigilance tasks were impractical in test batteries or in brain imaging studies. There have since been efforts made to construct shorter vigilance tasks that are analogs to the longer versions (Nuechterlein, Parasuraman & Jiang, 1983). Modern vigilance tasks are now available in many formats, including shorter duration tasks. Temple and colleagues (2000) provides an excellent example for such an abbreviated task. Other research has demonstrated a decline in performance that mirrors the vigilance decrement of longer tasks with this abbreviated task (Helton, Dember, Warm & Matthews, 2000; Matthews et al., 2001).

Vigilance tasks are inherently demanding and their relative stressful nature can induce considerable stress in participants (Hitchcock et al., 2003). Through constant engagement of cognitive resources when making target decisions under conditions of uncertainty and little opportunity for situational control stress is introduced (Helton et al., 2009). Evidence for the demanding nature of this task has also been accumulated through research research using the National Aeronautic and Space Agency Task Load Index (NASA-TLX), a measure of perceived mental workload (Dittmar et al., 1993; Grier et al., 2003; Warm et al., 2008; Temple et al., 2000). According to the transactional model, stress arises when task demands exceed the available resources. In a vigilance performance context, the strain reported by participants at the end of an experiment, such as fatigue, headaches or task-induced mood shifts (Warm, 1993) are negative consequences arising from sustained mental effort.

The sex of the operator has been a variable of interest in vigilance research since Mackworth's (1948) original studies. However, these investigations revealed no systematic differences and thus regarded as having little impact on theory or practical considerations of vigilant behaviour (Berch & Kanter, 1984; Davies & Parasuraman, 1982).

The inclusion of non-relevant task negative emotional and neutral images into the vigilance task provides a useful instrument to investigate emotional processing differences amongst men and women. Cognitive tasks, such as maintaining sustained attention involving the experience of emotion, have produced the most consistent gender differences (Kemp et al, 2003). Furthermore, emotions have been shown to directly and indirectly affect performance. Women are believed to be more readily influenced by negative pictures (Brody, 1995). Researchers have used a wide variety of stimuli to induce emotional experiences such as films (Leon-Carrion et al., 2006), visual images (Bradley et al., 2001), recollection of affect – specific events and face-recognition. For the present study, visual stimuli were used to trigger emotional responses and thus influence performance. These stimuli were presented during the vigilance task. The images were selected from the International Affective Picture System (IAPS); the IAPS is a database of coloured photographs to investigate processes in attention and emotion (Lang, Bradley & Cuthbert, 2001). It is increasingly utilized in brain imaging studies as it allows for the systematic selection of images with specific emotional content (Wrase et al., 2003). In the IAPS, images are categorized based on their emotional content, primarily on valence (positive-negative) and on the arousal (intensity) they elicit.

Functional near - infrared spectroscopy.

Emotional states can also be assessed and measured with physiological responses that are unaffected by the limitations that can occur with self-reports. Emotions can change rapidly and one drawback of traditional self-report measures is that they are not sensitive enough to account for these changes (Matthews & Desmond, 2010). In addition, self-report measures may reflect issues of social desirability. In the present case, for example, males may simply be socially conditioned to not admit distress; they may actually subjectively feel distress, but may be conditioned to not verbalize this in social settings. Neurophysiological and neuroimaging technologies have contributed to an understanding of brain functions, in particular for psychiatric disorders (Bunce, Izzetoglu, Izzetoglu, Onaral & Pourrezaei, 2007, Irani et al., 2007). Functional near-infrared spectroscopy (fNIRS) is an emerging optical technique that provides non-invasive and painless investigation of such brain functions (Hoshi, 2003; Irani et al., 2003; Leon-Carrion et al., 2006). It can also be used to measure hemodynamic changes occurring during specific tasks and map the temporal pattern of such changes. Unlike, traditional brain imagining techniques, near-infrared spectroscopy does not restrict participant’s movements and therefore can be used in more natural settings such as long-distance driving (Matthews & Desmond, 2010).

Functional optical imaging (as used with fNIRS) uses the optical properties of oxygenated tissue to measure regional changes in oxygen saturation levels in the brain (Bunce et al., 2007). Through the monitoring of blood flow volume and oxygenation, these techniques allow the functional imaging of brain activity. Light waves of certain wavelengths pass through the body except when they meet oxygenated or deoxygenated haemoglobin in the blood, where they are either absorbed or reflected. Functional near infra-red spectroscopy utilizes this principle and sends near-infrared light (range between 700nm to 900 nm) through the tissue (Lobbestael et al., 2009; Hoshi, 2003). On the frontal lobe, light waves travel two to three centimetres into the brain before they get absorbed by active and blood-filled areas of the brain (Bunce et al., 2007; Hoshi, 2003). The remaining light is absorbed by the fNIRS detectors placed outside the skull.

Functional near infrared spectroscopy has been validated in human (Kato et al., 2002; Hoshi & Tamura, 2001) and animal studies (Hoshi, Kobayashi & Tamura, 2001; Onoe, Watanabe, Tamura & Hayaishi, 1991). The degree of change measured in cerebral blood flow volume is consistent with other functional imaging techniques such as magnetic resonance imaging (fMRI), positron emission tomography (PET) or transcranial Doppler sonography (TCD) and thus suitable to use in experiments (Irani et al., 2007; Leon – Carrion et al., 2006; Toronov et al., 2001, Warm & Parasuraman, 2006).

Activation of the pre-frontal lobe cortex has been researched in regards to negative emotion and vigilance (Davidson, 2003; Helton et al., in press; Wang et al., 2007). Previous research involving brain imaging techniques such as functional near infrared spectroscopy have resulted in a number of findings, important for the present study. Firstly, the level of cerebral blood flow increases with the demands of the vigilance task (Helton et al., 2007; Warm et al., 1998). When an area of the brain becomes metabolically active, as during the performance of a cognitive task, carbon dioxide (CO_2) increases, leading to a dilation of blood vessels and thus result in greater blood flow to the region (Aaslid, 1986). Research using the fNIRS technique observed an increase in tissues oxygenation (as a consequence of greater blood flow velocity) for higher task demands (Toronov et al., 2001). Therefore, cerebral oxygenation is likely to elicit similar patterns as cerebral blood flow during vigilance tasks. An increased blood flow and greater metabolic activity during a vigilance tasks have been observed in the right hemisphere (Helton et al., 2007; Hitchcock et al, 2003; Schnittiger et al., 1997; Warm & Parasuraman, 1997). Secondly, emotional picture stimuli are associated with right-hemisphere functioning, while word or language stimuli are left-hemisphere dominant (Bryden, Free, Gagne & Groff, 1991). Negative picture stimuli generate greater right hemisphere activation than neutral picture stimuli (Helton et al., 2009). Additionally, emotional processing, especially of negative stimuli is also right-lateralized (Foster et al., 2008). Thirdly, vigilance decrement is also observed physiologically in a decline of cerebral blood flow (Warm & Parasuraman, 2006).

Additionally, it is apparent from previous brain imaging, lesion and psychophysical studies that vigilance involves the pre-frontal cortex and is lateralized to the right hemisphere (Helton et al., 2007; Hitchcock et al., 2003; Padro et al., 1991; Rueckert & Grafman, 1996). Previous research has suggested a lateralization of the brain in terms of functionality. Visual-spatial cognitive tasks have been found to elicit a higher blood flow velocity and activation in the right hemisphere, whereas linguistic tasks produce greater responses on the left (Vingerhoets & Stoobant, 1999; Warm, 1993). Pardo et al. (1996) proposes sustained attention to sensory stimuli to be a distinct neural system and this vigilance component is right-lateralized encompassing the right pre-frontal cortex. The neural structures identified to have an impact on vigilance and sustained attention are largely localized within the right pre-frontal and parietal lobe and the thalamus (Wang et al., 2005). Furthermore, the pre-frontal cortex might have a key influence on the brain's response to stress as it is a primary part for the emotion and vigilance networks (Wang et al., 2007).

Objectives

This study addresses a couple of shortcomings frequent in the area of performance differences between men and women in cognitive tasks.

Verbal self-reports are commonly used to explore relationships in emotional and stress research, however these measures are notorious for some problems (LaFrance & Banaji, 1992). They assume the person has full knowledge of their emotions and is able to record them accurately. According to Schwarz (in press) emotional reports are limited to their current feelings because affective states are fleeting and brief. The self-report of feelings is very subjective since the person has exclusive access to it, therefore they may be heavily influenced by issues of social self-presentation. Additionally, bias and error are likely to be introduced in self-report. Secondly, retrospective recall of stressful events may introduce gender differences as such responses are influenced by sociocultural beliefs about gender and stress (Shields, 1991). When used in a single measurement context, for example cross sectional studies, this limited approach does not provide the context a longitudinal study can provide. Comparisons across measurement points would better enable the ruling out of general differences in self-report (e.g. base rates).If men and women differ in stress reports generally, even when there is no actual stressor experienced, then the difference may simply be a reporting bias. Instead a vigilance task is chosen to investigate such potential differences because it proposes a stressful challenge in-of-itself and thus, to responses to a controlled stressor are measured, while also controlling for initial self-report levels (e.g. pre-stressor).

In the present study, self-reports were measure before and after each of two vigilance tasks. In addition to the use of subjective self-report measures of stress states, data on cerebral oxygen saturation is recorded to investigate physiological responses to stress. The use of physiological indices in research is limited and normally restricted to a few participants. However, their use can provide unique opportunities to enhance knowledge on cognitive processes in the understanding of stress and vigilance. Secondly, the results from the physiological measures may be useful to replicate previous findings associated with sustained attention tasks and the vigilance decrement.

Hypotheses

1. Performance: The combination of the sustained attention task and the emotional provoking pictures will create a stressful task that will affect the performance of men and women differently. Negative images have been shown to activate different patterns of emotional processing in women than in men. If women are threatened by the negative pictures, whereas, men are challenged by them; women are expected to show significantly different performance in the negative picture stimuli vigil.

2. Physiology: Cerebral oxygen saturation levels give an indication of activity in the brain. Whilst negative emotional stimuli are expected to affect both men and women’s performance on the task, women are expected to display a stronger response to these stimuli seen through greater activation in the brain (e.g. they should hyper react to the negative picture vigil).

3. Subjective-reports: If women are threatened by the negative pictures, whereas, men are challenged by them, it is expected women to show significantly different self-reports of stress in the negative picture stimuli vigil. Women after the negative picture stimuli should have elevated tense arousal and experience greater thought occurrence (e.g. worry). Men and women should not differ before a stressor has been experienced (e.g. at pre-task baseline), as the difference is due to stress reactions, not merely self-report bias.

Methods

Participants

The research was conducted with 40 participants (20 males). The age of participants ranged from 18 -50 years, (M= 24.18 years, SD=5.70). Participants were recruited from the University of Canterbury campus via flyers which asked for right-handed volunteers. This was further confirmed through an interview question and observing the hand used, while signing the consent form and filling out the questionnaires. All participants had normal hearing, and normal or corrected-to-normal vision based on self-report responses to sensory interview questions prior to the experimental session.

For participation $15 shopping vouchers were provided. A time was arranged with participants to conduct the experiment. An appointment was usually made on the hour to account for the experiments' hour long duration.

Materials

Vigilance.

An abbreviate vigilance task which including emotional or neutral pictures served as the performance measure. The task used was originally developed by Temple and associates (Temple et al., 2000). This abbreviated vigil exhibits many of the same effects as do longer duration vigilance tasks, including the vigilance decrement, a decline in signal detections over the watch-keeping period, and right cerebral dominance (Helton et al., 2007; Helton et al., 2009). The levels of stress and workload associated with the abbreviated task have been high, as they are in the case of long-duration tasks (Helton et al., 2000; Helton et al., 2007; Helton, Shaw, Warm, Matthews, & Hancock, 2008; Helton et al., 2009; Rose et al., 2002; Temple et al., 2000). Moreover, the effects of psychophysical manipulations of task difficulty, such as signal salience, and the role of pharmacological stimulants caffeine) on performance is similar to those on longer duration vigilance tasks (Temple et al.,

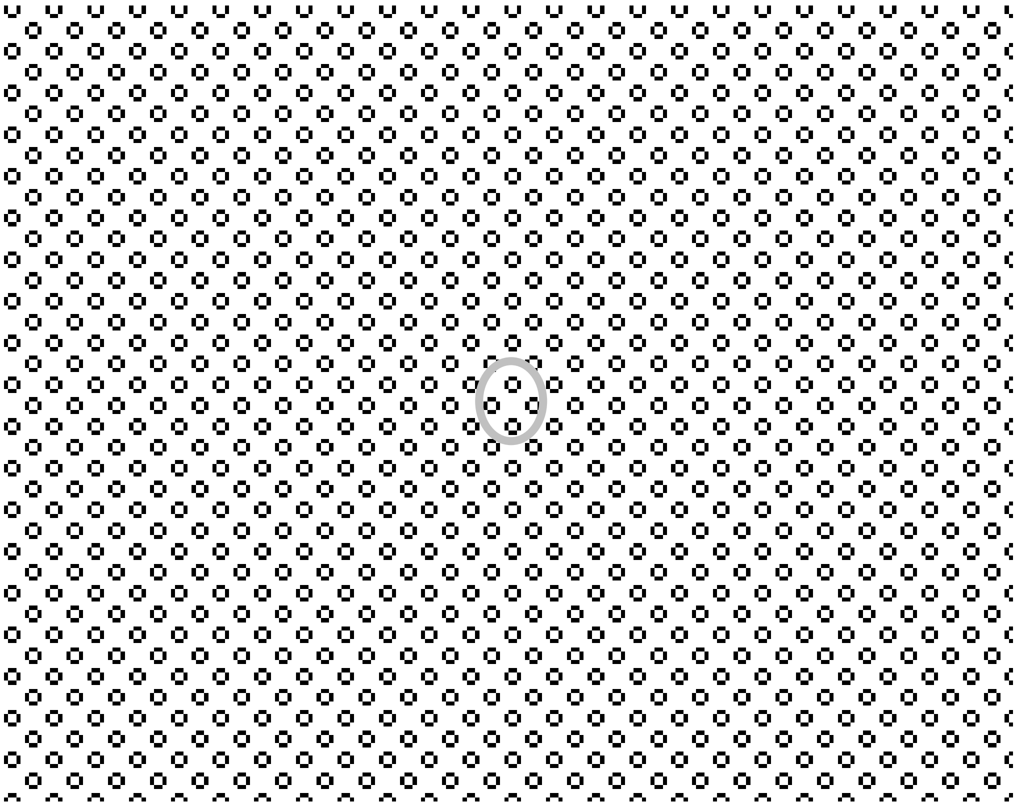

Fig. 1. An example of the visual mask with the target stimuli ‘O’

2000). Therefore, this short vigilance task was deemed useful for more applied settings.

This vigilance task requires the repetitive watch of a 8x6 mm light gray capital letter (‘O’, ‘D’ or backwards ‘D’) in a 24 point Avant Garde font exposed for 40 ms each against a visual mask made up of unfilled circle on a white background. This display is presented in Figure 1.

The circular elements depicted measure 1mm in diameter and are outlined by 0.25 mm thick black lines. A contrast ratio of 92 per cent between the black outline of the circles against the white background as indexed by Michaelson equation for spatial modulation (maximum luminance-minimum luminance/maximum luminance +minimum luminance) x 100 (Coren, Ward & Enns, 1999).

Further, circle elements are 3 mm in both horizontal and vertical direction and by 2.5 mm diagonally apart in space. The contrast ratio between the letter stimuli and the background was 45 per cent, also as indexed by the Michaelson equation. The letter stimuli vary randomly across participants and with each period of watch as well as all experimental conditions. The target stimuli (letter 'O') occurred with a probability of p=.20 and the non-target stimuli (letters 'D' and backward 'D') each occurred with a probability of p=.40. Participants respond to infrequently occurring target stimuli and do not respond to more frequently occurring distracter stimuli. Only responses to the critical targets were required and participants entered those through a keyboard in front of them. A response in up to 1000 ms after the onset of a critical stimulus was recorded as correct detection (hit). All other responses were registered as errors of commission (false alarms).

Each task has a duration of eight minutes, which is divided into four 2- minute periods. For the first two minutes, the task follows the above described pattern. In the remaining task periods, visual stimuli are introduced that vary in their level of distraction and so influence cognitive functioning on the task (Temple et al., 2000).

Participants completed this vigilance task twice, once with a set of negative and once with a set of neutral pictures. These images were selected from the International Affective Picture System (IAPS; Lang et al., 2001), which has been increasingly used to investigate emotional processes as it allows for systematic selection of images that range in emotional content (Bradley et al., 2001; Kemp et al., 2003; Lithari et al., 2010; Wrase et al., 2003). This system categorizes images according to their positive, neutral or negative arousal and valence on people. The IAPS contains pictures, which are separated into emotional arousing categories based on their normative ratings on a nine point rating scale for arousal and valence. Only neutral and negative images were selected for the experiment as such picture stimuli have been utilized in previous vigilance task experiments (Helton et al., in press; Helton et al., 2009). The pictures were chosen for either their low arousal and neutral valence (e.g. a spoon; mean rating of 3.0) or high arousal and negative valence (e.g. a gun pointing directly at the participant; mean rating of 6.0 or higher). Examples of such neutral and negative images are shown in Figures 2 and 3. The presentation of these images was random and brief (250 ms) in which the vigilance task was interrupted by the picture presentation, followed by the mask and then resumed.

Figure 2. Examples of the neutral picture stimuli

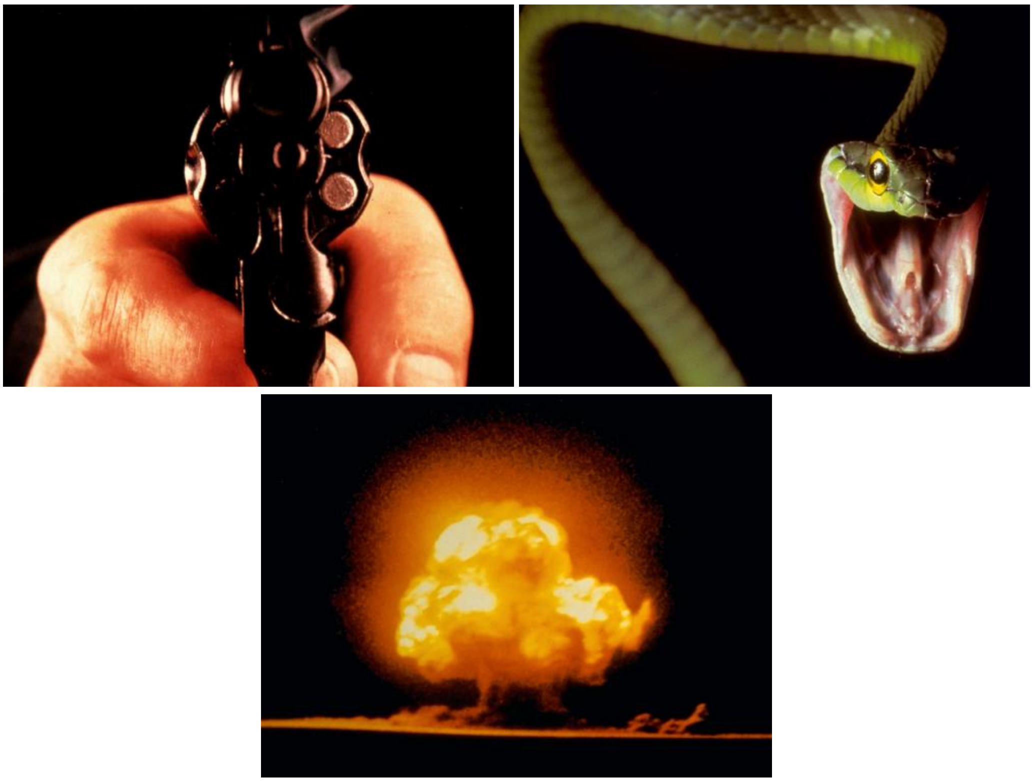

Figure 3. Examples of the negative picture stimuli

Functional near-infrared spectroscopy.

Optical imaging techniques such as functional near-infrared spectroscopy (fNIRS) are coming more popular due to their ability to map brain functions in a cost effective and non-invasive manner (Hoshi, 2003). The fNIRS measures hemodynamic changes within the brain, in particular regional oxygen (rSO_2) saturation in the cerebral cortex (Irani et al., 2007, Leon-Carrion et al., 2006). It has primarily been developed for clinical use and contributes to the understanding of brain functioning in psychiatric and neurological disorders such as mood disorders and Parkinson's disease (Irangi et al, 2007). Recently, research has demonstrated its potential in more applied settings and expanded the use of fNIRS to non-clinical samples (Leon-Carrion et al., 2006). Previous research has confirmed that fNIRS is as valid and reliable technology in comparison to more established neuroimaging techniques such as the fMRI (Hoshi, 2003; Irani et al., 2007).

A Nonin NIRS 7600 Near Infrared Cerebral Oximeter was used in this experiment. The equipment uses light diodes (LED's), emitting three wavelengths in the 700 nm to 900 nm. (Lobbestael, A., Roth, L. & Prior, M., 2009). It consists of a 30 cm x18 cm x13 cm monitor and a cable connecting the transmitter pads to the device as displayed in Figure 4. A blue-tooth connection ensured easy data transference for later data analysis.

Figure 4: f NIRS device with connection cable and transmitter pads

Dundee Stress State Questionnaire.

Participants responded to a 32-item paper- and- pencil version of the Dundee Stress State Questionnaire (DSSQ; Matthew et al., 2002), which provides a multidimensional assessment of transient states of stress, fatigue and arousal. A total of eleven scales are available, of which Energetic Arousal (EA), Tense Arousal (TA), Task Related Thoughts (TRT) and Task Unrelated Thoughts (TUT) were used. A five-point Likert scale was employed, where 1= not at all and 5 = extremely for the EA and TA scales and 1 = never and 5= very often for TRT and TUT scales. The DSSQ has been used in several studies involving vigilance tasks with visual stimuli (Grier et al., 2004; Mathews et al., 2001; Szalma et al., 2004). Additionally, the scales have also been used in previous vigilance studies (Helton et al., 2009; Helton & Warm, 2008; Hitchcock et al., 2003). The questionnaire was administered in three sessions: the pre-task version completed before the start of the vigilance task and a post-task version completed after each task (e.g. the neutral and negative picture stimuli conditions). This format was chosen to detect changes in states during the different time periods.

Procedure

The experiment was conducted in a small laboratory room with no external windows or other sources of visual or auditory distraction. Participants completed the experiment individually while seated eye-level approximately 40 cm in front of 24x32cm computer screen. Responses to the stimuli presented in the task were entered through a keyboard.

The experiment was conducted individually. When participants arrived at the laboratory, they were seated and given information about the experiment, in particular about the fNIRS procedure and were made aware that it is a non-invasive and painless technique to measure cerebral oxygen saturation. On completion of the informed consent, participants were asked to turn off any electronic and time-measuring devices. They then were given the pre-task version of the DSSQ, which took about 5 minutes to complete. Demographical data was collected as part of this questionnaire. After this, they were told to turn to the computer screen and sit comfortably in front of it.

The sensor pads for the fNIRS device were fitted to the participant's forehead. Subsequently, the participant's head movements were slightly restricted by the cables for this device. In addition, participants were instructed to minimize body movements and refrain from speaking, while five minutes of baseline was recorded.

The participants during this baseline period where instructed to stare at the blank video display screen with their eyes-open and to focus on relaxed wakefulness.

Following this baseline period, participants completed the above described vigilance task in one of two orders, either the task with the neutral picture stimuli embedded and the task with the negative picture stimuli embedded, or vice versa. Prior to the beginning of the main experimental sessions, participants were provided a two minute practice session with auditory feedback on hits and misses of the target stimuli to familiarize themselves with the task. Participants were asked to respond by pressing a button for selected target stimuli and withhold for non-target items. The first of the two vigilance tasks followed after this practice period. The first two minutes of both the neutral and negative picture tasks were without pictures embedded; these picture-free periods were included to make the picture presentation unpredictable to the participant and they were excluded from the analyses. After the first two minutes, five pictures were randomly shown in each of the three remaining continuous two minute watch periods (the first picture appeared two minutes into the task, from that point there were three 2-minute periods of watch with five pictures randomly appearing within them). During the presentation of the images, the vigilance task was not active. The pictures were displayed in the center of the screen for 250 ms. After picture stimuli were offset, there was a 1000 ms inter-stimulus interval (the visual mask). Since picture presentation was randomized, the probability of any picture being immediately followed by a critical stimuli was $p = .20$ and by a neutral stimuli was $p = .80$. Participants were unaware of the duration of the tasks.

A post questionnaire with slightly altered questions is administered after this first block of the task. A second baseline follows the completion of the post questionnaire. The participants were exposed to a second set of target stimuli with the alternative picture orientation. At the end of this task, the physiological measuring devices were removed and the final post questionnaire was administered. There were no additional rest breaks during the task.

After the questionnaires were complete, participants were debriefed and received the vouchers.

Results

Performance

Correct Detections.

In the vigilance task correct detections were defined as the key presses to the rare target letter stimuli. There were 23 target letters (O) in each 2min period of watch. The correct detections were subjected to a 2 (sex: male versus female) x 2 (emotional stimuli versus neutral stimuli) x 3 (periods of watch) mixed analysis of variance (ANOVA). The analysis of variance is robust to violations of normality and transformations of data, such as arcsin transformations, can lead to problems interpreting results, therefore, the raw correct detections scores were analyzed The results of this analysis revealed two significant main effects. First, correct detections were higher in the neutral stimuli condition (M = 19.7, SE = .601) than the negative stimuli condition (M = 18.79, SE = .79), $F\ (1, 38) = 4.33$, $\rho = .04$, $\eta_p^2 = .10$. Second, there is a main effect of correct detection over the three periods of watch. While the overall rate in period 1 is M = 19.99, SE = .62, it slowly declines over period 2 (M = 19.15, SE = .72) and period 3 (M = 18.61, SE = .76), $F\ (2, 76) = 5.16$, $\rho < .001$, $\eta_p^2 = .19$. These two main effects are graphically displayed in Figure 5. There were no significant effects or interactions with sex.

False Alarms.

False alarm rates were extremely rare in the study, as they are in previous studies with the abbreviated vigilance task (Helton et al. 2000; Helton & Warm, 2008; Temple et al., 2000). Consequently, due to a floor effect false alarm rates were not further examined.

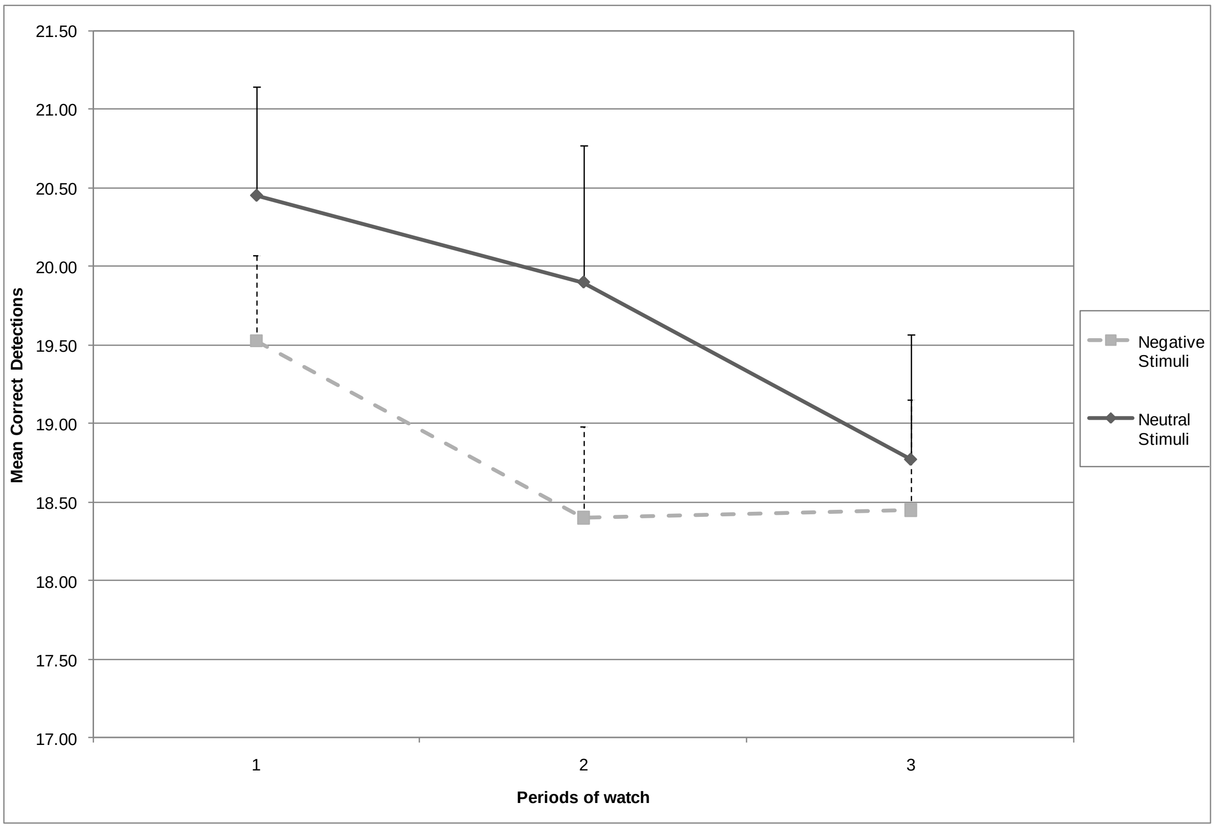

Fig. 5. Main effects of emotional stimuli and period of watch for correct detections

Physiology

A relative measure of regional oxygen saturation (rSO_2) is used in this analysis as recommended in previous studies (Yoshitani, Kawaguchi, Tatsumi, Kitaguchi & Furuya, 2002). The rSO_2 scores utilized in the following analysis are based upon the relative percentage change to the baseline taken prior to the experimental task. Consequently, a score of 0 would reflect no change to the baseline. A 2 (emotional stimuli vs. neutral stimuli) x 2 (hemisphere: left vs. right) x 3 (periods of watch) x 2 (sex: males, females) mixed ANOVA revealed several significant findings. Firstly, a significant interaction effect was observed between sex and time period, F (2, 76) = 4.10, ρ =.034, η_p^2 = .10. This interaction can be seen in Figure 2 (error bars represent the standard error).

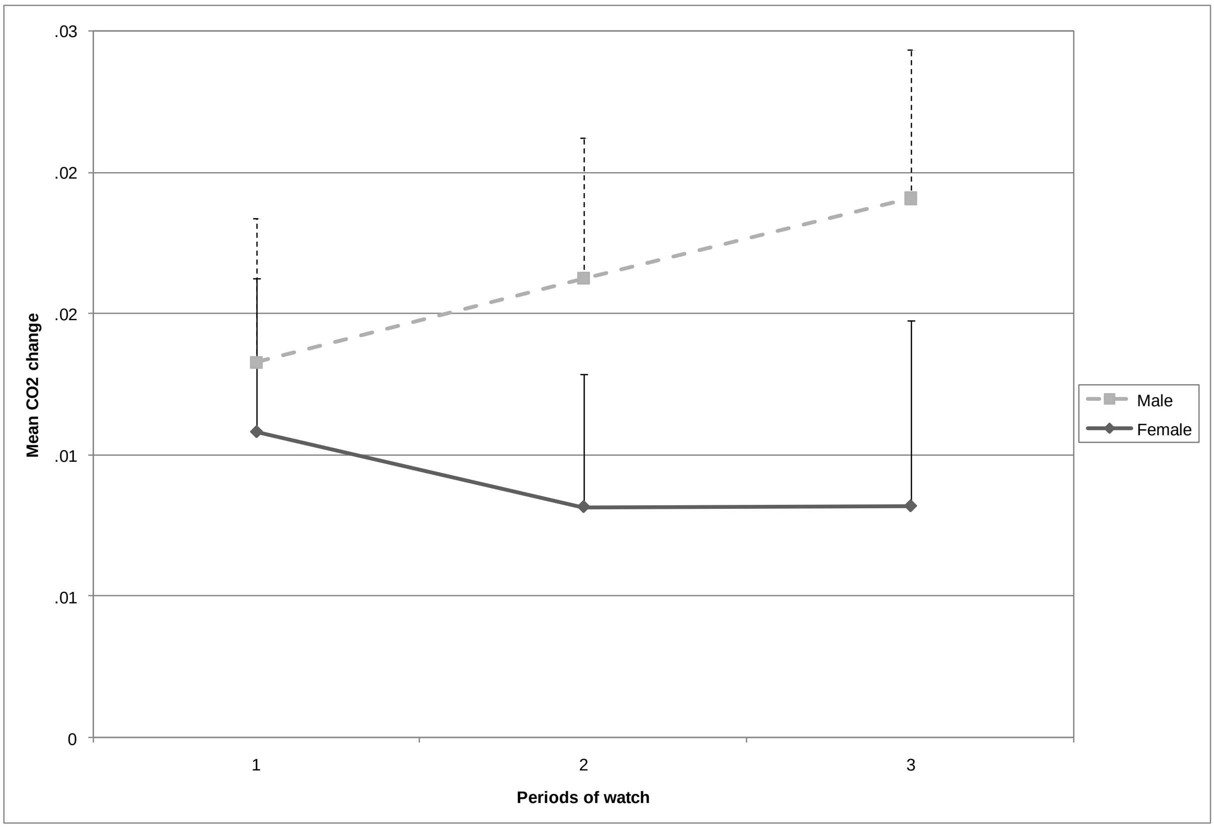

Fig. 6. Mean rSO_2 change in females and males over time of task

The analysis also revealed a significant interaction between the hemispheres and the observed periods of watch, F (2, 76) = 5.10, ρ=.021, η_p^2 = .10. A graphical depiction is shown in Figure 3 (errors bars represent the standard error). Here, changes in oxygen saturation in the right hemisphere stay constant during the task, while they increase in the left hemisphere. Although not a significant finding, a trend (ρ = .079) is indicated by the interaction between hemispheres and emotional stimuli. While the negative emotional stimuli creates greater change in right hemisphere (M = .013, SE = .003) than the left hemisphere (M = .011, SE = .002), the results for the neutral stimuli show a greater change in the left (M = .014, SE = .004) than the right hemisphere (M = .012, SE = .004).

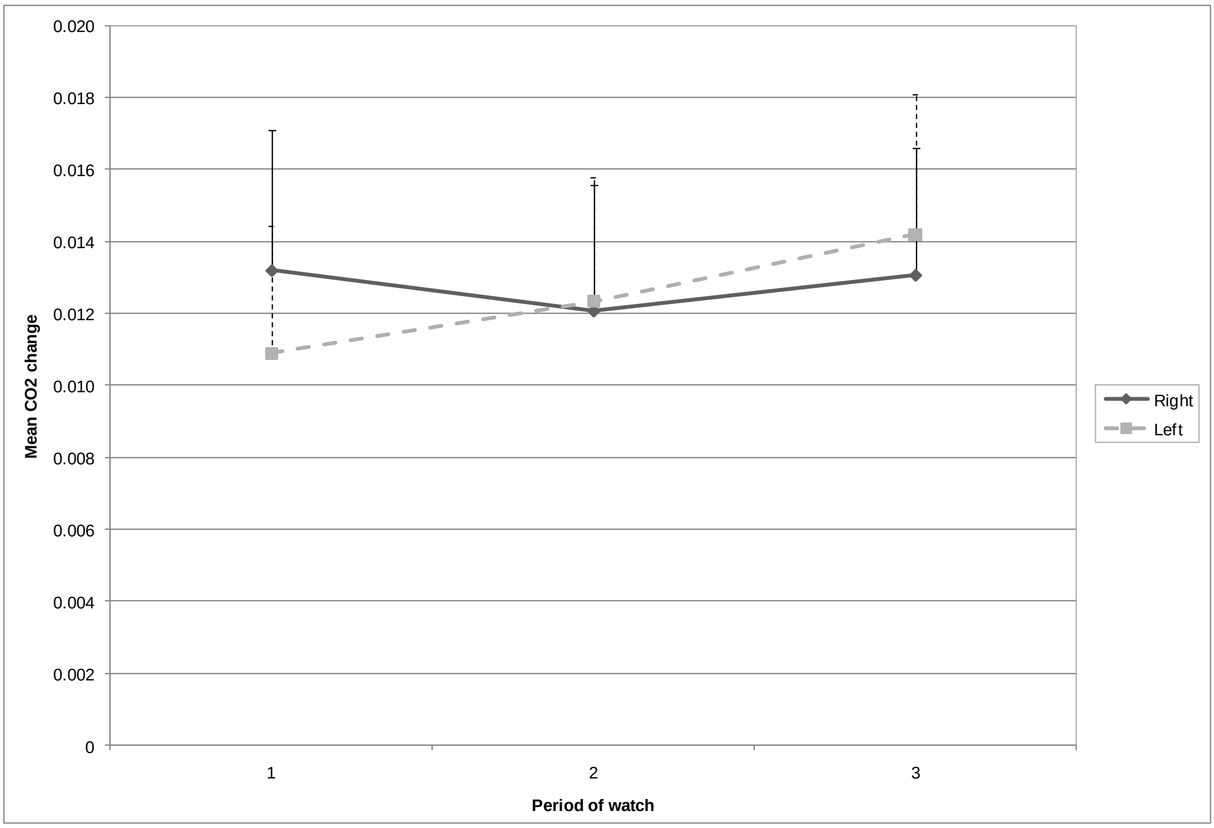

Fig 7. Mean rSO_2 change in the right and left hemisphere over time of task

Subjective Self-Reports

Subjective ratings on Energetic Arousal (EA), Tense Arousal (TA), Task Related Thoughts (TRT) and Task Unrelated Thoughts (TUT) are used to examine task-induced changes in these subjective states. All answers to the questionnaire were made in the same response format (on a scale of 1-5, where 1= not at all and 5 = extremely for EA and TA; 1 = never and 5= very often for TRT and TUT), therefore the unstandardised raw scores were used in further analyses as recommended by Rogosa (1995). Additionally, the two arousal measures and the two thought measures were grouped together in the following analyses.

Energetic and tense arousal.

Data from these measure was analyzed using a 3 (time of measurement: pre-task; post-negative, post-neutral) x 2 (measure: EA and TA) x 2 (sex: male vs. female) mixed or split-plot ANOVA. Overall, women (M = 3.01, SE = .074) reported higher levels of arousal than men (M = 2.76, SE = .0.74), F (1,38) = 5.68, $\rho<.05$, $\eta_p^2 = .13$. Secondly, there was a main effect for the measure, where Energetic Arousal (M = 3.14, SE =.08) was significantly higher than Tense Arousal (M = 2.63, SD = .07), F (1, 38) = 20.40, $\rho<.05$, $\eta_p^2 = .35$ as well as a main effect for time of measurement. Here, the overall mean rating at measurement time 1 is M = 2.80, SE = .059. It increases with both negative stimuli at measurement time 2 (M = 3.00, SE = .075) and neutral stimuli at measurement time 3 (M = 2.86, SE = .064), F (2, 76) = 4.168, $\rho < .05$, $\eta_p^2 = .10$. Additionally, there was also a significant time of measurement by measure interaction, F (2, 76) = 5.21, $\rho<.05$, $\eta_p^2 = .12$. The interaction is displayed in Figure 8 (errors bars represent the standard error).

Task-related and unrelated thoughts.

The self-report measures of Task-Related Thoughts and Task-Unrelated Thought were analyzed using a 3 (time of measurement: pre-task; post-negative, post-neutral) x 2 (measure: EA and TA) x 2 (sex: male vs. female) mixed or split-plot ANOVA. Women (M = 2.21, SE = .10) reported having overall more thoughts during the task than men (M = 1.74, SE = .10), F(1, 38) = 12.24, $\rho=.001$, $\eta_p^2 = .24$. There was a main effect for the measurement in that TRT (M = 2.32, SE = .092) were significantly higher than TUT (M = 1.62, SE =.075), F (1, 38) = 47.95, $\rho<.05$, $\eta_p^2 =.56$.

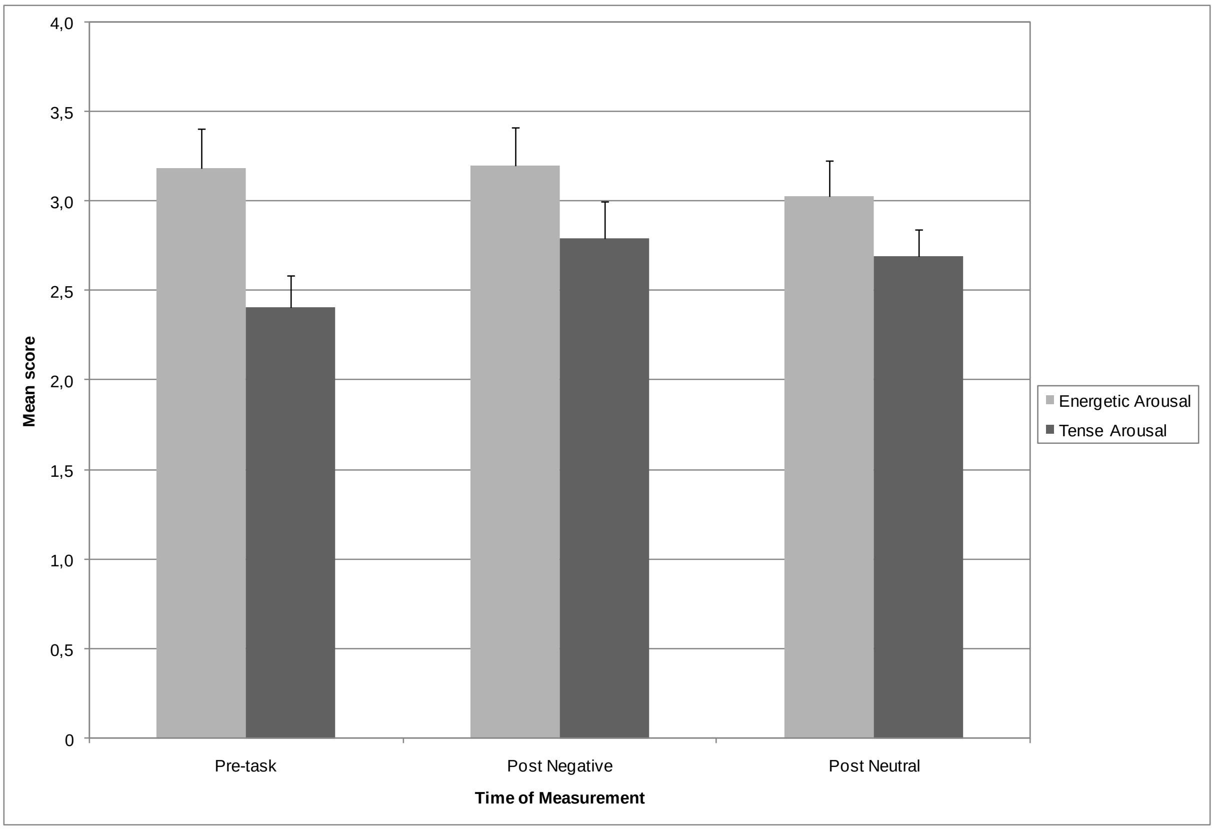

Fig 8. Mean EA and TA arousal scores at the times of measurement

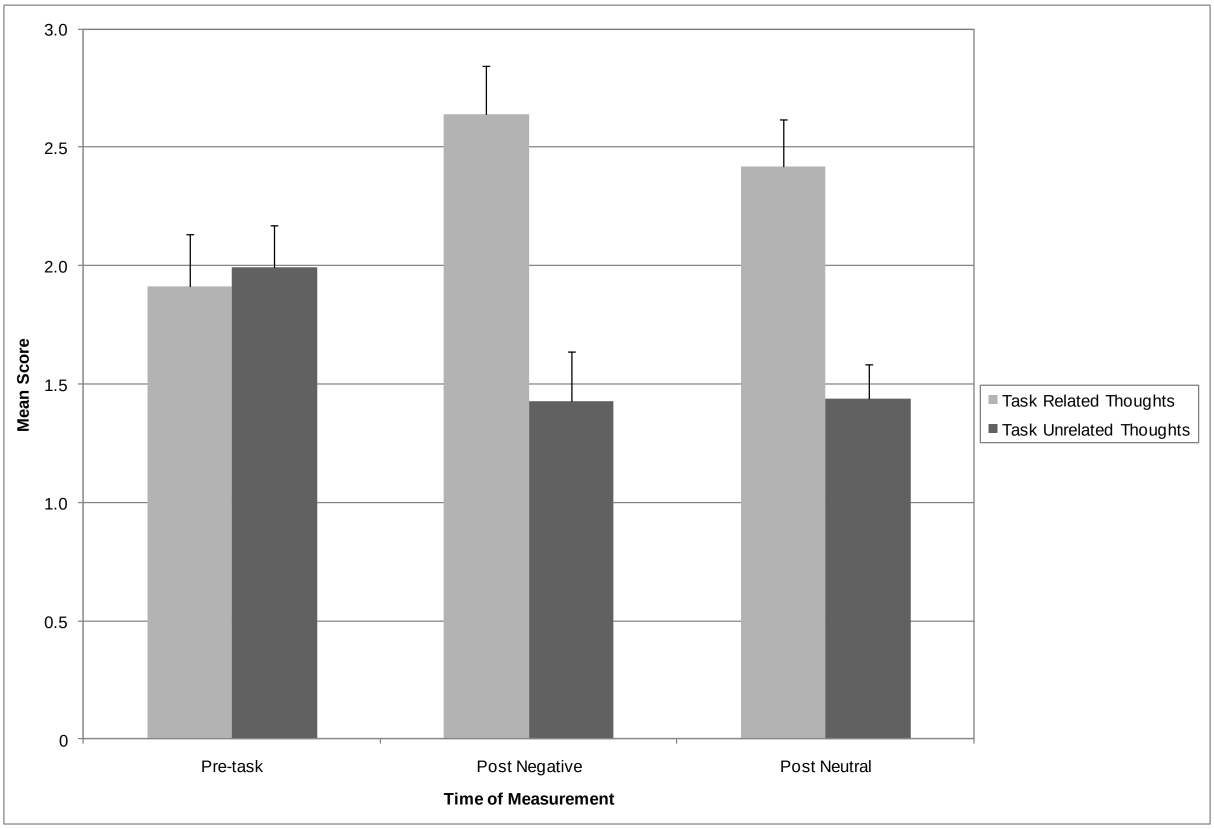

Fig 9. Mean scores of TRT and TUT scores at times of measurement

A significant time of measurement by measure interaction, $F(2, 76) = 30.95$, $\rho<.001$, $\eta_p^2 = .45$ as displayed in Figure 9, also results from this analysis. Here, task related thoughts increase significantly with the negative and neutral picture task conditions, while task unrelated thoughts are decreasing compared to the pre-task measurement.

Lastly, a trend ($\rho<.07$) becomes apparent for an interaction between the measure and the sex of the participant, $F(1, 38) = 3.52$, $\eta_p^2 = .09$, as shown in Figure 10 (error bars represent the standard error). Here the overall higher scores of women on both measures become apparent.

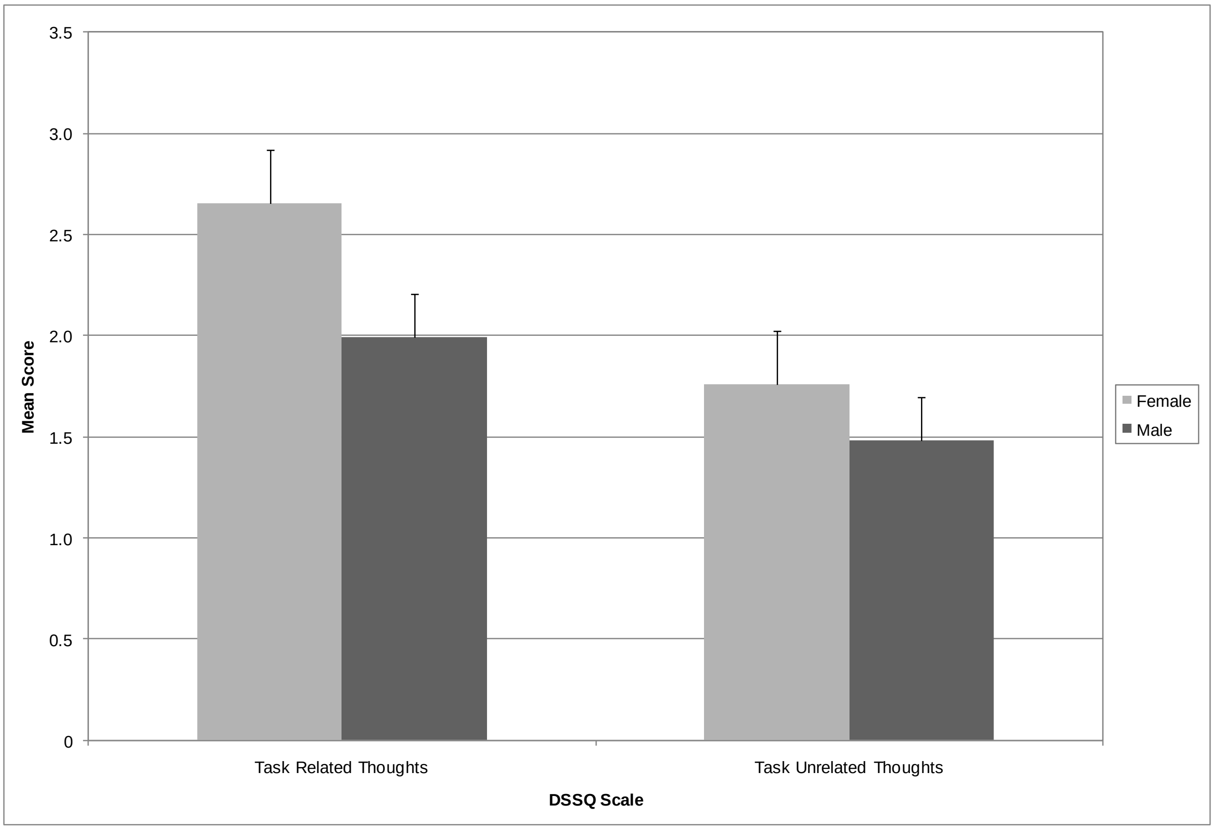

Fig. 10. Mean scores for TRT and TUT for females and males

Discussion

This investigation aimed to explore performance differences between men and women during stressful situations. Firstly, it is expected that women will be threatened by negative images and will show different performance in the negative picture stimuli vigil. If women do show a stronger response to negative stimuli, this should be evident through greater brain activity. Finally women are expected to have greater self-reports of stress.

Performance under Stress

Performance is influenced by emotional stimuli as confirmed by previous research concerning emotional visual stimuli. One explanation is that visual stimuli consume additional attention resources, which have less time to get replenished and therefore negatively affect performance (Matthews et al., 2001). In this study negative pictures were found to have more of a detrimental impact on performance than neutral pictures.

A decline in the detection of target stimuli over the duration of the task supports the existence of the previously described vigilance decrement (Davies & Parasuraram, 1984; See et al., 1995; Warm et al., 1993). Performance during the neutral picture presentation declines steadily over the watch; however performance for negative pictures remains consistent after an initial drop. Especially unpleasant and negative pictures can mimic the effects of danger and threat and thus activate the body’s defence mechanisms (Bradley et al., 2001). As previously mentioned, neutral stimuli do not elicit the same response on performance as negative ones. This could be a sign that negative stimuli impact more on the cognitive systems that are involved in performance.

Changes in Physiological Activation

In this study, measurement of regional oxygen level saturation change reflected activation changes in brain activity, indicating physiological state changes. Although not statistically significant, there was a trend for the negative picture condition to produce a larger reaction in the right hemisphere, while more activation of the left hemisphere was associated with the neutral picture condition. Previous literature concerning emotional processing has produced evidence that negative stimuli are processed in the right hemisphere (Foster et al., 2008). The trend for negative emotions to be characterized by greater right hemisphere activation ($rSO_{2)}$, and neutral pictures more by activation in the left hemisphere is in line with earlier research emotional content activates specific areas in the brain. A greater change in activation has been recorded in the right hemisphere for negative pictures and neutral pictures resulted in greater changes in the left.

Secondly, sex different patterns of pre-frontal cortex activation were observed. For women, hemispheric activation dropped and stabilized over the course of the vigilance task. In contrast, men’s activation patterns revealed a constant increase of hemispheric activation. Kemp et al. (2003) also reported a reduction in this direction. Previous research identified different temporal course and pre-frontal cortex activation in men and women (Leon-Carrion et al., 2006). Another explanation for the different findings in initial readings could be the relatively smaller head/brain size of women as compared to men. The smaller physiological features of women such as smaller head sizes and associated cerebral blood flow volume may account for differences more than task induced changes do. Women, for example, have higher resting cerebral blood velocities than men. Nevertheless, there was no interaction between sex and the picture condition, raises doubts about large sex differences in emotional processing during the tasks. Previous research suggests that sustained attention on this abbreviated task is right-lateralized (Helton et al., 2007).

However in the present experiment activity in the right hemisphere stayed constant over the duration of the task, while a steady increase in activation in the left hemisphere are observed. Recent research (Helton et al., 2010) suggests vigilance may not actually be as lateralized as previously considered, and that task context may alter lateralization of the vigilance. The inclusion of the picture stimuli may have also altered cerebral lateralization.

More doubts about sex differences in brain activation have been raised by Rabinowitz, Dean, Petetot and de Courten-Myers (1999), who concluded that the brain areas involved in cognitive processes have such a complex interaction and are so variable in activation of areas that a comparison is impossible. Therefore, predictions about functionality of certain areas of the brain do not correspond to with the observed abilities, e.g. thicker cortex in females that seem to be activated during spatial visualization. The basic conclusion regarding sex differences in the physiological measure employed here is that none of them suggested significant sex differences in reaction to the negative (e.g. threatening) picture stimuli.

Stress Perceptions

Subjective stress perceptions were accessed through the Dundee Stress State Questionnaire. Emotional stimuli have also been found to influence stress states as defined by Matthews et al. (2001). Energetic Arousal, representing an indication of mental alertness and Tense Arousal, an indication of distress, are the highest after the negative stimuli condition. This finding is consistent with negative stimuli simultaneously being alerting and threatening.

Energetic Arousal does decreases slightly in the emotional neutral stimuli as compared to the pre-task condition, indicating a mental fatigue, without the benefits of the energizing aspect of the threatening images.

An increase in Tense Arousal in relation to the pre-task measure is reported after each of the experimental conditions, indicating that the task is demanding and stressful (e.g. induces tension) This stress partly results from task overload apparent from the cognitive workload sustaining attention during a repetitive task (Matthews et al., 2002) and emotional images eliciting stressful responses in the experiment.

As a further confirmation for the demands of the task, an increase in Task-Related Thoughts (TRT) and a decrease in Task-Unrelated Thoughts (TUT) after each of the experimental conditions as compared to the pre-task measurement were observed. Especially, negative emotional stimuli affect the level TRT and TUT in this pattern. The significantly higher number of TRTs could be an indicator the stressful nature of the task. Secondly, the decline in TUTs and an increase in TRTs as compared to the pre-task measurement also indicate a change in subjective experience states. Additionally, negative picture stimuli elicited highest TRT and the lowest TUT ratings, hinting an additional cognitive load, validating the resource theory.

A high amount of task-related thoughts indicated mental involvement with the task (e.g. task commitment). This finding confirms mental engagement with the task, rather than thinking about other things, and provides further support for the resource theory of the vigilance decrement. Additionally, this finding can also be used to explain the stressful nature of the vigilance task utilized.

When the results of the experiment are examined in terms of sex differences, the striking results reveal no significant differences in performance under stress. Even the added stress through emotional stimuli did not impact this result. The present study finds no differences in performance or neural activation patterns, merely in the subjective ratings of the participants. Similar findings are observed when analyzing the physiological data. Again, no sex differences were found in pre-frontal cortex blood tissue oxygenation. The significant findings from the DSSQ are on all measures taken that females have consistently higher scores than their male counterparts. Women reported higher tense and energetic arousal, as well as more task-related and unrelated thoughts, than men. These sex differences occur even before the stressor is introduced. It can therefore be concluded that women show initially higher scores overall that may not be the result from the task at all.

From the above results, it can be concluded that men and women do not differ much in their real objective reaction to stress, however women do report higher levels of stress overall, which does not translate in the behavioral or physiological reality. This finding is consistent with other research that observed sex as a research variable (Berch & Kanter, 1984; Davies & Parasuraman, 1982). One exemption to this rule is that men and women do perform differently in vigilance tasks that include spatial discrimination stimuli (Dittmar et al., 1993). However, no performance differences were identified in the temporal task. This suggests that performance is task-dependent rather than a global factor. Moreover, differences in spatial performance have been observed before.

Several researchers have suggested that the responses on self-reports measurements are influenced by sociocultural beliefs about gender differences (Barnett et al., 1998; LaFrance & Banaji, 1992). In past stress research, women consistently reported higher levels of stress and increased vulnerability to stress related outcomes (Brody, 1995; Hyde, 2005; Matud, 2004). These differences however provide no indication of whether they actually experience more stress. It has been reported that women are more emotionally expressive than men (Fischer & Manstead, 1995; Kring & Gordon, 1998). This could have important implications for their subjective stress ratings. This research, the expression of emotions seems to be more heavily socialized than the experience of emotions. After examining culture differences it becomes apparent that such variance in emotional expressiveness might be a cultural phenomenon more pronounced in Western countries. Gender differences were larger in individualist and less traditional orientated cultures. Brody (1995) argues that expressiveness is influenced by cultural values and the value placed on the gender role. LaFrance and Banaji (1992) also argue that emotions are more associated with women and that these beliefs are developed and manifested early on.

Socialization of gender roles occurs in a number of settings such as parents, peers and intuitions. Socialization explanations suggest that women are encouraged to show emotion while men are educated to refrain from such emotions hence offering an explanation for the higher reported self-measures for women (Feldman - Barrett, 2003; Fischer & Manstead,1995).

This study adds to the growing body of knowledge in task induced stress. It also adds to the understanding of emotional processes during stressful tasks and aids as a confirmation of the gender similarity hypothesis. The negative impact of proclaimed gender differences is far-reaching. Stereotypes can impact on women's opportunities in the work place, resolution of conflicts or self-esteem problems (Hyde, 2005). Times are, however, changing, as more and more female role-models of women are being introduced who are less emotional and more action oriented. A case in point would be the changes from traditional popular culture female characters, like Snow White or Sleeping Beauty (helpless damsels in distress) to Mulan, who indeed reverses the paradigm and saves the "prince". Likewise, men are being more encouraged to express themselves emotionally, hence the rise in popular culture of metro-sexualism.

Limitations

Firstly, the sample utilized in the experiment was a sample of convenience drawn from a university student pool, limiting the scope of the results. There may be certain influences on this population that makes it more homogenous. Secondly, as previously found with other neuroimaging techniques the measuring technique itself can introduce error. Individuals differ anatomically in size of the brain and important structures involved in cognitive processes as well as in physiological arousal, which can introduce systematic measuring errors (Schlaefer et al., 1995). A third limitation can be seen in the power of the sample in the experiment. However, past research investigated this vigilance task using a similar sample size (Helton et al., in press). Here, significant results confirm the ability of such a sample size to yield meaningful results. Additionally, past experimental studies measuring physiological responses in vigilance use smaller sample sizes (Leon-Carrion et al., 2006).

A final limitation of the study concerns the greater environment as this study was conducted in the month after a major earthquake in Christchurch. This could have led to elevated stress levels in all participants masking potential sex differences. Given that the findings concerning performance in vigilance tasks are consistent with findings in the literature, this seems highly unlikely. In addition a recent study by Kemp and colleagues (unpublished manuscript) regarding the stress responses to Christchurch's recent earthquake, like the present study, demonstrates that while women self-report higher levels of stress, when actual measures of performance are examined, there are no sex differences.

Conclusions

Most conclusively, the results from the abbreviated vigilance, the fNIRS and the Dundee Stress State Questionnaire confirm previous findings for vigilance experiments. Findings from this experiment add to the existing research body of the impact of emotions on performance in stressful situations, especially in vigilance. Findings from this experiment add to the existing research body on the impact of emotions on performance in stressful situations, especially in vigilance. Evidence for a larger impact of negative emotions in performance includes the finding of a vigilance decrement. Additionally, the stress state measures revealed that the vigilance task is stressful and mentally demanding for participants.

Furthermore, no differences in performance were evident in men and women, however, women did report significantly higher stress states than men. There is no support for this difference in either performance or behavioural data. The question of sex differences can be looked at from many different angles, with most reported sex differences being a combination of both biological and social components. While there are statistical differences in ability, differences are also socially reinforced.

Finally, the functional near-infrared spectroscopy is further established as a successful technique for non-invasive blood oxygenation measurement to enhance the study of cognitive processes in a wide variety of tasks.

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Appendix A

Department of Psychology

University of Canterbury

CONSENT FORM

Simulated target detection/Vigilance experiment

I have read and understood the description of the above-named project. On this basis I agree to participate as a subject in the project, and I consent to publication of the results of the project with the understanding that anonymity will be preserved.

I understand also that I may at any time withdraw from the project, including withdrawal of any information I have provided.

I note that the project has been reviewed ***and approved*** by the University of Canterbury Human Ethics Committee.

NAME (please print): …………………………………………………………….

Signature:

Date:

Appendix B

Department of Psychology

University of Canterbury

Information Sheet

You are invited to take part in a research project conducted as part of a Master's degree from the University of Canterbury. Before you decide to take part in this experiment it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Please ask if there is anything that is not clear or if you would like more information.

This research project aims to investigate whether distractive stimuli have an influence on task performance. Secondly, it determines if psychophysiological indices, such as near infrared spectroscopy, are predictive of any changes in this performance. Lastly, it explores potential relationships between the self-reported state measures (questionnaires), psychopysiological indices and performance metrics.

Your participation in this research involves doing a simulated target detection task. Prior this, you will complete a questionnaire and some physiological recording devices will be fitted. These devices track the blood oxygen level. There will be some practice run through the task (much like in a videogame). In this task, you will be asked to respond (press a button) to a set of selected target items and withhold (ignore) a set of other non-target items. Some distracting stimuli in form of images have been included. The goal is to select the target items as quickly and accurately as possible. After completion of the target detection task and a post-task questionnaire, the physiological devices will be removed. Finally, some questions about the effects of that the September 4 earthquake might have had on you will be asked.

If you decide to take part you have the right to withdraw from the project at any time, including withdrawal of any information provided.

In the performance of the tasks and application of procedures there are minimal risks. There are no known side effects of physiological recording equipment used. They are non-invasive, non-painful and comfortable. The detection task is similar to playing a video. The images shown during the task are no worse than what can be seen on the news.

It may be that at some point you would like to obtain some psychological or medical advice about the effects of the experiment and/or earthquake on you. If so, the following organisations might be a good starting point:
Relationship Services Whakawhanaungatanga on 03 366 8804 or 0800 RELATE (0800 735 283) or
Lifeline – 24 hour telephone counselling 0800 543 35

The results and summaries of data collected as part of the project may be published, but you may be assured of the complete confidentiality of data gathered in this investigation: the identity of participants will not be made public without their consent. To ensure anonymity confidentiality, you will be assigned a unique number code for the purpose of the study. All records containing personally identifying information are stored in secure locations, are only accessible by authorized staff and is destroyed once the research is completed.

The project is being carried out as a requirement for a Master's degree in Psychology by Ulrike Ossowski under the supervision of Deak Helton, who can be contacted at (03) 364 2998, ext. 7999. He will be pleased to discuss any concerns you may have about participation in the project. All parts of this project have been reviewed and approved by the University of Canterbury Human Ethics Committee.

Appendix C

Department of Psychology

University of Canterbury

Debriefing Sheet

The current research focuses on the effects of task appraisals, neutral and negative affective picture stimuli and target characteristics. It utilizes a target detection task that is further complicated by emotionally arousing pictures. I am predicting that there are gender differences in performance of this task and exploring possible explanation of this phenomenon such as situational appraisals of challenge and threat.

Functional near infrared spectroscopy is being used to establish whether the assumed negative pictures produce more cerebral activation then less distractive images and are therefore supporting the psychological and task performance measurements.

Self-report measures before, during and after task participation of energetic arousal, tense arousal, task related and unrelated thoughts will be used to evaluate the differences between the wandering thoughts and the mental fatigue theories of vigilance decrement. Additionally, information about threat and challenge appraisal of the task will be used to assess its impact on subsequent performance. Finally, questions about the recent earthquake help to determine the potential impact on the performance on the vigilance task.

This research will provide a clearer picture of the causes of the vigilance decrement which may allow for better design of jobs and roles requiring sustained attention (remote –controlled tanks, monitoring of radars and sonar as well as other security surveillance). Determining the impact of additional arousing stimuli on performance can help to design support systems for human operators in such job roles.

Appendix D

PRE-QUESTIONNAIRE

General Instructions. This questionnaire is concerned with your feelings and thoughts at the moment. Please answer **every** question, even if you find it difficult. Answer, as honestly as you can, what is true of **you**. Your answers will be kept entirely confidential. You should try and work quite quickly. The first answer you think of is usually the best.

Are you: **Left-handed** **Right-handed**

Age: ___

Please indicate how well each word describes how you feel **AT THE MOMENT** (circle the answer from 1 to 5).

Not at all = 1 A little bit = 2 Somewhat = 3 Very much = 4 Extremely = 5

1.	Energetic	1	2	3	4	5
2.	Relaxed	1	2	3	4	5
3.	Alert	1	2	3	4	5
4.	Nervous	1	2	3	4	5
5.	Passive	1	2	3	4	5
6.	Tense	1	2	3	4	5
7.	Jittery	1	2	3	4	5
8.	Sluggish	1	2	3	4	5
9.	Composed	1	2	3	4	5
10.	Restful	1	2	3	4	5
11.	Vigorous	1	2	3	4	5
12.	Anxious	1	2	3	4	5
13.	Unenterprising	1	2	3	4	5
14.	Calm	1	2	3	4	5
15.	Active	1	2	3	4	5
16.	Tired	1	2	3	4	5

Please indicate roughly how often you had each thought **DURING THE LAST TEN MINUTES.**

Never = 1 Once = 2 A few times = 3 Often = 4 Very often = 5

17.	I thought about how I should work more carefully.	1	2	3	4	5
18.	I thought about how much time I had left.	1	2	3	4	5
19.	I thought about how others have done on this task.	1	2	3	4	5
20.	I thought about the difficulty of the problems.	1	2	3	4	5
21.	I thought about my level of ability.	1	2	3	4	5
22.	I thought about the purpose of the experiment.	1	2	3	4	5
23.	I thought about how I would feel if I were told how I performed.	1	2	3	4	5
24.	I thought about how often I get confused.	1	2	3	4	5
25.	I thought about members of my family.	1	2	3	4	5
26.	I thought about something that made me feel guilty.	1	2	3	4	5
27.	I thought about personal worries.	1	2	3	4	5

28.	I thought about something that made me feel angry.	1	2	3	4	5
29.	I thought about something that happened earlier today.	1	2	3	4	5
30.	I thought about something that happened in the recent past (last few days, but not today).	1	2	3	4	5
31.	I thought about something that happened in the distant past.	1	2	3	4	5
32.	I thought about something that might happen in the future.	1	2	3	4	5

POST-QUESTIONNAIRE

General Instructions. This questionnaire is concerned with your feelings and thoughts during the task. Please answer **every** question, even if you find it difficult. Answer, as honestly as you can, what is true of **you**. Your answers will be kept entirely confidential. You should try and work quite quickly. The first answer you think of is usually the best.

Please indicate how well each word describes how you felt **DURING THE TASK** (circle the answer from 1 to 5).

Not at all = 1 A little bit = 2 Somewhat = 3 Very much = 4 Extremely = 5

1.	Energetic	1	2	3	4	5
2.	Relaxed	1	2	3	4	5
3.	Alert	1	2	3	4	5
4.	Nervous	1	2	3	4	5
5.	Passive	1	2	3	4	5
6.	Tense	1	2	3	4	5
7.	Jittery	1	2	3	4	5
8.	Sluggish	1	2	3	4	5
9.	Composed	1	2	3	4	5
10.	Restful	1	2	3	4	5
11.	Vigorous	1	2	3	4	5
12.	Anxious	1	2	3	4	5
13.	Unenterprising	1	2	3	4	5
14.	Calm	1	2	3	4	5
15.	Active	1	2	3	4	5
16.	Tired	1	2	3	4	5

Please indicate roughly how often you had each thought **DURING THE TASK.**

Never = 1 Once = 2 A few times = 3 Often = 4 Very often = 5

17.	I thought about how I should work more carefully.	1	2	3	4	5
18.	I thought about how much time I had left.	1	2	3	4	5
19.	I thought about how others have done on this task.	1	2	3	4	5
20.	I thought about the difficulty of the problems.	1	2	3	4	5
21.	I thought about my level of ability.	1	2	3	4	5
22.	I thought about the purpose of the experiment.	1	2	3	4	5
23.	I thought about how I would feel if I were told how I performed.	1	2	3	4	5

24.	I thought about how often I get confused.	1	2	3	4	5
25.	I thought about members of my family.	1	2	3	4	5
26.	I thought about something that made me feel guilty.	1	2	3	4	5
27.	I thought about personal worries.	1	2	3	4	5
28.	I thought about something that made me feel angry.	1	2	3	4	5
29.	I thought about something that happened earlier today.	1	2	3	4	5
30.	I thought about something that happened in the recent past (last few days, but not today).	1	2	3	4	5
31.	I thought about something that happened in the distant past	1	2	3	4	5

POST-QUESTIONNAIRE 2

General Instructions. This questionnaire is concerned with your feelings and thoughts during the task. Please answer **every** question, even if you find it difficult. Answer, as honestly as you can, what is true of **you**. Your answers will be kept entirely confidential. You should try and work quite quickly. The first answer you think of is usually the best.

Please indicate how well each word describes how you felt **DURING THE TASK** (circle the answer from 1 to 5).

Not at all = 1   A little bit = 2   Somewhat = 3   Very much = 4   Extremely = 5

1.	Energetic	1	2	3	4	5
2.	Relaxed	1	2	3	4	5
3.	Alert	1	2	3	4	5
4.	Nervous	1	2	3	4	5
5.	Passive	1	2	3	4	5
6.	Tense	1	2	3	4	5
7.	Jittery	1	2	3	4	5
8.	Sluggish	1	2	3	4	5
9.	Composed	1	2	3	4	5
10.	Restful	1	2	3	4	5
11.	Vigorous	1	2	3	4	5
12.	Anxious	1	2	3	4	5
13.	Unenterprising	1	2	3	4	5
14.	Calm	1	2	3	4	5
15.	Active	1	2	3	4	5
16.	Tired	1	2	3	4	5

Please indicate roughly how often you had each thought **DURING THE TASK.**

Never = 1   Once = 2   A few times = 3   Often = 4   Very often = 5

17.	I thought about how I should work more carefully.	1	2	3	4	5
18.	I thought about how much time I had left.	1	2	3	4	5
19.	I thought about how others have done on this task.	1	2	3	4	5

20.	I thought about the difficulty of the problems.	1	2	3	4	5
21.	I thought about my level of ability.	1	2	3	4	5
22.	I thought about the purpose of the experiment.	1	2	3	4	5
23.	I thought about how I would feel if I were told how I performed.	1	2	3	4	5
24.	I thought about how often I get confused.	1	2	3	4	5
25.	I thought about members of my family.	1	2	3	4	5
26.	I thought about something that made me feel guilty.	1	2	3	4	5
27.	I thought about personal worries.	1	2	3	4	5
28.	I thought about something that made me feel angry.	1	2	3	4	5
29.	I thought about something that happened earlier today.	1	2	3	4	5
30.	I thought about something that happened in the recent past (last few days, but not today).	1	2	3	4	5
31.	I thought about something that happened in the distant past.	1	2	3	4	5